

Chromosome counts and karyological studies on six taxa of the Egyptian Asteraceae

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Abstract

Chromosome numbers are presented for six taxa of the Egyptian Asteraceae. Karyological studies were carried out on those species. These studies include karyotype features, idiogram drawn and chromosome lengths. A diploid chromosome number of $2n=40$ in *Centaurea glomerata* VAHL and $2n=18$ in *Anacyclus alexandrinus* WILLD. & *Tanacetum santolinoides* (DC.) FEINBRUN & FERTIG are reported here for the first time, while polyploid number of $2n=72$ with $x=9$ is recorded in *Aster squamatus* (SPRENG.) HIERON.

Key words: Egyptian Asteraceae, Chromosome counts, Karyotype analysis.

Introduction

The Asteraceae is one of the four largest families of Angiosperms (1535 genera & 23000 species, BREMER 1994) and is considered by most taxonomists the highest in the scale of evolution. Also in the flora of Egypt, the Asteraceae are well represented (92 genera & 226 species, EL-HADIDI & FAYED 1995).

Chromosomes have been considered as sources of valid taxonomic criteria (MOORE 1978, JACKSON 1984). The karyotype data also appear to be of taxonomic value in providing a logical basis for the redistribution of genera in tribes. Karyotype studies were principally based on the idea that symmetrical karyotypes are more primitive than asymmetrical ones; longer chromosomes more primitive than shorter ones; chromosome arms of equal length (median centromeres) were more primitive than chromosomes with arms of unequal length; low basic numbers had given rise to higher ones. These features are based on the comparison between karyotypes of known relative antiquity, as determined through classical taxonomy (SHARMA 1990).

Some studies have dealt with chromosomal features of members of Asteraceae in Egypt. Examples of these include; AMIN (1957) on the genus *Launaea* CASS.; ASHRI (1957); ASHRI & KNOWLES (1960) on genus *Carthamus* L.; NORDENSTAM (1972) on some Compositae from Egypt; AMIN (1973) on some Egyptian plants; AMIN (1978) on the genera *Launaea* CASS. & *Onopordum* L.; KAMEL (1996) on 47 species of the Asteraceae; BADR et al. (1997) on 23 species of subfamily Asteroideae and KAMEL (1999) on 10 species of the Asteraceae.

In the present study, chromosome numbers and detailed karyotype features of six taxa of the Egyptian Asteraceae including four new counts are reported.

Materials and Methods

Materials of the six taxa were collected from various habitats in Egypt. Voucher specimens are deposited at the herbarium of Biological Sciences and Geology Department, Faculty of Education, Ain Shams University, Roxy, Cairo, Egypt. The studied species, the localities from which they were collected and date of collection are given in Table 1.

Cytological preparations were carried out on root tips obtained from seeds germinated on sterile moist filter paper in Petri dishes at 25°C. Roots were pretreated with 0.05% colchicine solution for 2–3 hours, fixed in Carnoy for 24 hours and stored in 70 % ethanol at 4°C. Cytological preparations were made using the Feulgen squash method. The well-spread c-metaphase chromosomes were photographed from temporary preparations at magnifications of 2000 ×. Slides of the original karyotypes are also preserved in the Laboratory of Cytogenetics of the same department.

A karyogram for each taxon was constructed by arranging the chromosomes in homologous pairs by order of their length and arm ratio as measured from the photographic prints. The number of chromosome types was determined as described by LEVAN et al. (1965). Measurements of chromosome length were taken on the same photographs of the karyogram.

The variation in chromosome length (MCL) and chromosome arm ratio (MAR) within the karyotype has been estimated by calculating the standard error (SE) of these parameters. Karyotype asymmetry deduced from the ratio between the short arms of the chromosomes and their total length was expressed as total form percent (TF %) as proposed by HUZIWARA (1962). Karyotype asymmetry expressed by the ratio between chromosome arms has been also estimated as the intrachromosomal asymmetry index (A_1) as

suggested by ROMERO ZARCO (1986).

The value of A_1 is considered to be close to zero if all chromosomes are metacentric and near to one if all chromosomes are telocentric. Karyotype asymmetry due to the ratio between size of different chromosomes has been also estimated as the interchromosomal asymmetry index (A_2) using PEARSON's dispersion coefficient, that is the ratio between the standard deviation and the mean chromosome length (ROMERA ZARCO 1986).

The existence of previous chromosome counts for the studied taxa has been verified in the indexes of plant chromosome numbers by FEDOROV (1969), GOLDBLATT (1981, 1984, 1985, 1988) and GOLDBLATT & JOHNSON (1990, 1991, 1994, 1996 & 1998).

Table 1. Taxa studied and their localities. Collected by Dr. E. A. KAMEL; vouchers in herbarium of Biological Sciences & Geology Department, Faculty of Education, Ain Shams University, Cairo, Egypt

No.	Tribe	Taxa	Locality	Date of collection
1	Cardueae	<i>Centaurea glomerata</i> VAHL.	Rasheed – Alex. Road	5.4.2000
2	Cardueae	<i>Notobasis syriaca</i> (L.) CASS.	Alex. Matrouh Road, near Marakia	4.4.2000
3	Gnaphalieae	<i>Lasiopogon muscoides</i> (DESF.) DC.	Wadi Al-Arbeen, Santé Catharine, South Sinai	23.2.2000
4	Astereae	<i>Aster squamatus</i> (SPRENG.) Hieron.	Cairo – Suez Desert Road (65 km.)	30.3.2000
5	Anthemideae	<i>Anacyclus alexandrinus</i> Willd.	Bourg El-Arab	4.4.2000
6	Anthemideae	<i>Tanacetum santolinoides</i> (DC.) FEINBRUN & FERTIG	Wadi Al-Arbeen, Santé Catharine, South Sinai	23.2.2000

Results and Discussions

A summary of the cytological data of the taxa studied is given in Table 8 and their karyotypes & idiograms are illustrated in Figs. 1 & 2.

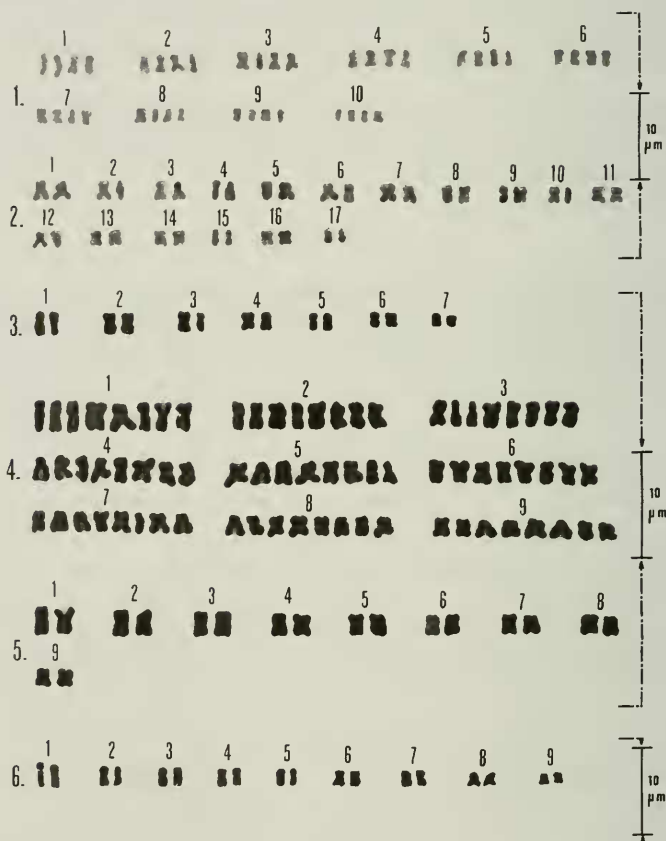


Fig. 1. Karyotypes of the studied taxa

- (1) *Centaurea glomerata* VAHL
- (2) *Notobasis syriaca* (L.) CASS.
- (3) *Lasiopogon muscoides* (DESF.) DC.
- (4) *Aster squamatus* (SPRENG.) HIERON.
- (5) *Anacyclus alexandrinus* WILLD.
- (6) *Tanacetum santolinoides* (DC.). FEINBRUN & FERTIG

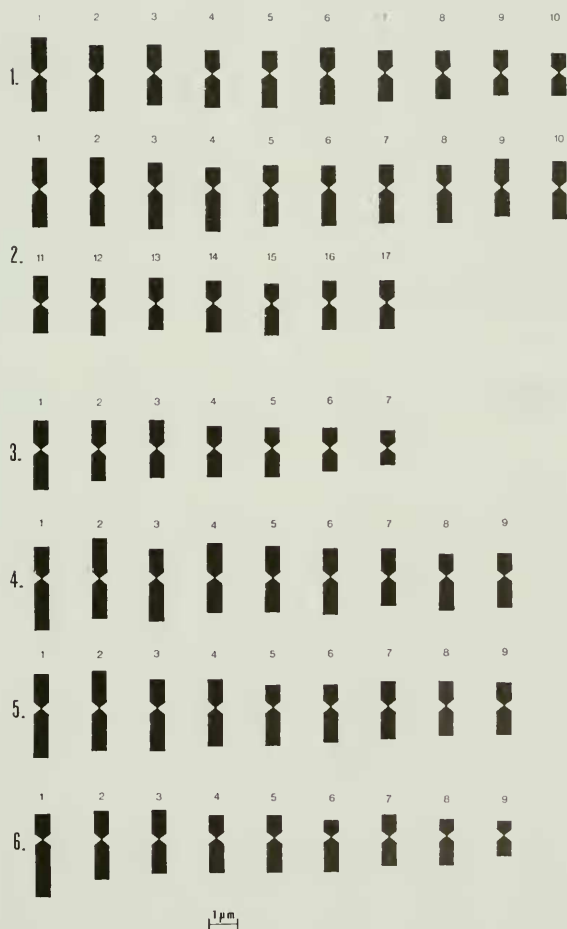


Fig. 2. Idiograms of the studied taxa, constructed with respect to total chromosome length (TCL).

1- *Centaurea glomerata* VAHL

This species is common in the Mediterranean coastal region, in sandy soils. The examined specimen was collected from Rosetta (Rasheed). It was found to be tetraploid with a somatic chromosome number of $2n=40$ and basic number of $x=10$. The chromosome count for this taxaon is recorded here for the first time. The previous counts for other species of the genus *Centaurea* L. in the Egyptian flora were $2n=16$ in *C. aegyptiaca* L. (KAMEL 1996); $2n=18$ in *C. alexandrina* DEL. (KAMEL 1996) and $2n=20$ in *C. alexandrina* DEL. & *C. calcitrapa* L. (GOLDBLATT 1984, 1988, GOLDBLATT & JOHNSON 1990 and KAMEL 1996). The karyotype is comprised of metacentric chromosomes in four groups. The chromosomes are short ($MCL=1.94\pm0.11\mu m$), the MAR is 1.19 ± 0.05 and TF % is 45.77. The karyotype of this species was found to be the most symmectric one, compared to the other species in this study. The symmetry of the karyotype is also indicated by the values of A_1 (0.15) and A_2 (0.18). Detailed measurements of this species are presented in Table 2.

**Table 2. Measurements of somatic chromosomes of
Centaurea glomerata VAHL**

Chr. pair	Chr. length (μm)	Relative length	Short arm (μm)	Long arm (μm)	R. value	Relative R. value	Chromosome type
1	2.60	13.40	1.29	1.31	1.02	8.54	m
2	2.26	11.65	0.99	1.27	1.28	10.72	m
3	2.06	10.62	1.00	1.06	1.06	8.88	m
4	2.04	10.52	0.84	1.20	1.43	11.98	m
5	2.00	10.31	0.82	1.18	1.44	12.06	m
6	1.98	10.21	0.92	1.06	1.15	9.63	m
7	1.75	9.02	0.77	0.98	1.27	10.64	m
8	1.70	8.76	0.82	0.88	1.07	8.96	m
9	1.57	8.09	0.77	0.80	1.04	8.71	m
10	1.44	7.42	0.66	0.78	1.18	9.88	m
Total	19.40	100.00	8.88	10.52	11.94	100.00	—
Mean ± SE	1.94 ± 0.11	—	0.89 ± 0.06	1.05 ± 0.06	1.19 ± 0.05	—	—

2- *Notobasis syriaca* (L.) CASS. (= *Carduus syriacus* L. , *Cirsium syriacum* (L.) GAERTNER)

This species is rare and found in roadsides, waste places or stony hillsides in the Mediterranean coastal region. The present specimen in this study was collected from Alexandria – Marsa Matrouh coastal road, near Marakia. This species has a somatic chromosome number of $2n=34$ in 17 homologous pairs. This basic number was previously reported in GOLDBLATT (1984) and GOLDBLATT & JOHNSON (1991). The karyotype consists of 16 m och 1 sm chromosome pairs. The MCL is $2.01 \pm 0.06 \mu\text{m}$, the MAR is 1.35 ± 0.07 , the TF % is 42.94, the A_1 is 0.23 and A_2 is 0.12. The detailed measurements of this species are found in Table 3.

Table 3. Measurements of somatic chromosomes of *Notobasis syriaca* (L.) CASS.

Chr. pair	Chr. length (mm)	Relative length	Short arm (μm)	Long arm (μm)	R. value	Realtive R. value	Chromosome type
1	2.40	7.02	1.10	1.30	1.18	5.15	m
2	2.38	6.96	1.06	1.32	1.25	5.46	m
3	2.30	6.72	0.86	1.44	1.67	7.29	m
4	2.28	6.66	0.74	1.54	2.08	9.08	sm
5	2.14	6.26	0.82	1.32	1.61	7.03	m
6	2.14	6.26	0.84	1.30	1.55	6.77	m
7	2.04	5.96	0.84	1.20	1.43	6.24	m
8	2.00	5.85	0.84	1.16	1.38	6.03	m
9	2.00	5.85	0.98	1.02	1.04	4.54	m
10	1.96	5.73	0.88	1.08	1.23	5.37	m
11	1.94	5.67	0.96	0.98	1.02	4.45	m
12	1.93	5.64	0.87	1.06	1.22	5.33	m
13	1.80	5.26	0.88	0.92	1.05	4.59	m
14	1.78	5.20	0.78	1.00	1.28	5.59	m
15	1.78	5.20	0.68	1.10	1.62	7.07	m
16	1.70	4.97	0.80	0.90	1.13	4.93	m
17	1.64	4.79	0.76	0.88	1.16	5.07	m
Total	34.21	100.00	14.69	19.52	22.90	99.99	–
Mean	2.01		0.86	1.15	1.35		
±	±	–	±	±	±	–	
SE	0.06		0.03	0.05	0.07		

3- *Lasiopogon muscoides* (DESF.) DC.

This species is also rare in the flora of Egypt and found in gravelly soils. The material of this species was collected from Wadi Al-Arbeen, Santé-Catharine in South Sinai. A somatic chromosome number of $2n=14$ in only seven pairs was recorded in this species. The karyotype is comprised of metacentric chromosomes only. The MCL is $1.80 \pm 0.14 \mu\text{m}$, the MAR is 1.22 ± 0.07 , the TF % 45.04, A_1 is 0.17 and A_2 is 0.21. This species has the shortest chromosomes in the present study. Detailed chromosome measurements are presented in Table 4.

Table 4. Measurements of somatic chromosomes of *Lasiopogon muscoides* (DESF.) DC.

Chr. pair	Chr. length (μm)	Relative length	Short arm (μm)	Long arm (μm)	R. value	Relative R. value	Chromosome type
1	2.37	18.82	0.97	1.40	1.44	16.86	m
2	2.10	16.68	0.98	1.12	1.14	13.35	m
3	1.97	15.65	0.97	1.00	1.03	12.06	m
4	1.73	13.74	0.76	0.97	1.28	14.99	m
5	1.67	13.26	0.67	1.00	1.49	17.45	m
6	1.52	12.07	0.72	0.80	1.11	13.00	m
7	1.23	9.77	0.60	0.63	1.05	12.30	m
Total	12.59	99.99	5.67	6.92	8.54	100.01	—
Mean	1.80		0.81	0.99	1.22		
$\pm$	$\pm$	—	$\pm$	$\pm$	$\pm$	—	—
SE	0.14		0.06	0.09	0.07		

4- *Aster squamatus* (SPRENG.) HIERON. (= *Conyza squamata* SPRENG.)

This species is introduced and naturalized in moist places. The specimen is collected from Cairo – Suez desert road (65 km). This species was found to be octoploid with somatic chromosome number of $2n=72$ and a basic chromosome number of $x=9$. The previous chromosome counts for this species was $2n=20$ with $x=10$ (FEDOROV 1969, GOLDBLATT 1981, 1984, 1985, GOLDBLATT & JOHNSON 1991 and KAMEL 1996). The karyotype of this species consists of 1 pair of metacentric chromosomes with median point and 8 pairs of metacentric chromosomes with median region. This species was found to

have the longest chromosomes in the present study. The MCL is 2.34 ± 0.12 μm . The karyotype symmetry measures i.e. MAR (1.29 ± 0.07), the TF % (44.11), A_1 (0.20) and A_2 (0.15) indicate also a high degree of symmetry in the karyotype of this species. Measurements of chromosomes are found in Table 5.

**Table 5. Measurements of somatic chromosomes of
Aster squamatus (SPRENG.) HIERON.**

Chr. pair	Chr. length (μm)	Relative length	Short arm (μm)	Long arm (μm)	R. value	Relative R. value	Chromosome type
1	2.91	13.83	1.13	1.78	1.58	13.61	m
2	2.72	12.93	1.35	1.37	1.01	8.70	m
3	2.52	11.98	1.03	1.49	1.45	12.49	m
4	2.44	11.60	1.22	1.22	1.00	8.61	m
5	2.34	11.12	1.11	1.23	1.11	9.56	m
6	2.22	10.55	0.95	1.27	1.34	11.54	m
7	2.05	9.74	0.93	1.12	1.20	10.34	m
8	2.02	9.60	0.81	1.21	1.49	12.83	m
9	1.82	8.65	0.75	1.07	1.43	12.32	m
Total	21.04	100.00	9.28	11.76	11.61	100.00	—
Mean ± SE	0.12	—	1.03 ± 0.06	0.07	0.07	—	—

5 - *Anacyclus alexandrinus* WILLD.

This species is common in sandy places and calcareous rock habitats. The present material was collected from Burg El-Arab. A somatic chromosome number of $2n=18$ in 9 homologous pairs of metacentric chromosomes with median region (9m) were recorded in this species for the first time. The calculated MCL is 2.24 ± 0.12 μm and MAR is 1.32 ± 0.05 . The TF % is 43.35, the A_1 is 0.23 and A_2 is 0.16. Chromosome measurements are found in Table 6.

**Table 6. Measurements of somatic chromosomes of
Anacyclus alexandrinus WILLD.**

Chr. pair	Chr. length (μm)	Relative length	Short arm (μm)	Long arm (μm)	R. value	Relative R. value	Chromosome type
1	2.87	14.25	1.20	1.67	1.39	11.74	m
2	2.70	13.41	1.25	1.45	1.16	9.80	m
3	2.47	12.26	1.02	1.45	1.42	11.99	m
4	2.27	11.27	0.95	1.32	1.39	11.74	m
5	2.07	10.28	0.82	1.25	1.52	12.84	m
6	2.03	10.08	0.83	1.20	1.45	12.25	m
7	1.97	9.78	0.90	1.07	1.19	10.05	m
8	1.93	9.58	0.93	1.00	1.08	9.12	m
9	1.83	9.09	0.83	1.03	1.24	10.47	m
Total	20.04	100.00	8.73	11.44	11.84	100.00	—
Mean	2.24		0.97	1.27	1.32		
±	±	—	±	±	±	—	—
SE	0.12		0.05	0.07	0.05		

6- *Tanacetum santolinoides* (DC.) FEINBRUN & FERTIG (= *Pyrethrum santolinoides* DC.)

This species is rare in the mountains and rocky habitats in Sinai. The examined material in the present study was collected from Wadi Al-Arbeen, Santé-Catharine in South Sinai. This species was found to be diploid with a somatic chromosome number of $2n=18$ and a basic chromosome number of $x=9$. This chromosome count is also reported here for the first time. The karyotype of this species consists of 6 pairs of metacentric chromosomes (6 m) and 3 pairs of submetacentric chromosomes (3 sm). The MCL is $1.98 \pm 0.16 \mu\text{m}$. The karyotype asymmetry measures i.e. MAR (1.64 ± 0.13), the TF % (38.31), A_1 (0.36) and A_2 (0.24) indicate a high degree of asymmetry in the karyotype of this species. Measurements of chromosomes are found in Table 7.

**Table 7. Measurements of somatic chromosomes of
Tanacetum santolinoides (DC.) FEINBRUN & FERTIG**

Chr. pair	Chr. length (μm)	Relative length	Short arm (μm)	Long arm (μm)	R. value	Relative R. value	Chromosome type
1	2.86	16.04	0.86	2.00	2.33	15.82	sm
2	2.40	13.46	1.04	1.36	1.31	8.89	m
3	2.20	12.34	0.96	1.24	1.29	8.76	m
4	2.02	11.33	0.78	1.24	1.59	10.79	m
5	2.00	11.22	0.80	1.20	1.50	10.18	m
6	1.76	9.87	0.56	1.20	2.14	14.53	sm
7	1.75	9.81	0.75	1.00	1.33	9.03	m
8	1.60	8.97	0.56	1.04	1.86	12.63	sm
9	1.24	6.95	0.52	0.72	1.38	9.37	m
Total	17.83	99.99	6.83	11.00	14.73	100.00	—
Mean ± SE	1.98 ± 0.16	—	0.76 ± 0.06	1.22 ± 0.12	1.64 ± 0.13	—	—

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Table 8. Summary of the cytological features of the studied taxa

No.	Taxa	Previous chromosome counts	2n	(x)	MCL (μm) $\pm$ SE	MAR $\pm$ SE	TF %	A ₁	A ₂	Karyotype formula
1	<i>Centaurea glomerata</i> VAHL.	–	40	10	1.95 $\pm$ 0.11	1.19 $\pm$ 0.05	45.77	0.15	0.18	(10 m)
2	<i>Notobasis syriaca</i> (L.) CASS.	34	34	17	2.01 $\pm$ 0.06	1.35 $\pm$ 0.07	42.94	0.23	0.12	(16 m + 1sm)
3	<i>Lasiopogon muscoides</i> (DESF.) DC.	14	14	7	1.80 $\pm$ 0.14	1.22 $\pm$ 0.07	45.04	0.17	0.21	(7 m)
4	<i>Aster squamatus</i> (SPRENG.) HIERON.	20	72	9	2.34 $\pm$ 0.12	1.29 $\pm$ 0.07	44.11	0.20	0.15	(1 M + 8 m)
5	<i>Anacyclus alexandrinus</i> WILLD.	–	18	9	2.24 $\pm$ 0.12	1.32 $\pm$ 0.05	43.35	0.23	0.16	(9 m)
6	<i>Tanacetum santolinoides</i> (DC.) FEINBRUN & FERTIG	–	18	9	1.98 $\pm$ 0.16	1.64 $\pm$ 0.13	38.31	0.36	0.24	(6 m + 3sm)

MCL = Mean chromosome length
 SE = Standard error
 MAR = Mean arm ratio
 TF % = Total form
 A₁ = Intrachromosomal asymmetry index
 A₂ = Interchromosomal asymmetry index
 M = Metacentric point chromosome
 m = Metacentric region chromosome
 sm = Submetacentric chromosome